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A method for non-invasive deep brain stimulation as treatment for PTSD

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Nearly 1 in 15 people in the US will suffer from post-traumatic stress disorder (PTSD) in their lifetime. Approximately 40% of patients fail to respond to pharmacotherapy and 30% receiving therapy continue to suffer a decade after the trauma. Targets of PTSD neurocircuitry, such as the amygdala, are directly accessible through invasive and relatively high-risk deep brain stimulation (DBS). DBS of the amygdala (BLn) produced symptomatic improvement in a rat model of PTSD, suggesting the utility of this target in humans. A proof-of-concept clinical trial of DBS of the amygdala (BLn) in humans is currently underway.

We present a method for non-invasive and focal neurostimulation of deep brain regions, subcranial magnetic stimulation (SMS). The biophysical basis of SMS is similar to transcranial magnetic stimulation (TMS). In contrast, SMS delivers electromagnetic fields superiorly through the palate, allowing direct access to deep brain regions strongly implicated in psychiatric disorders like PTSD.

To study the feasibility of SMS, we designed an intra-oral electromagnetic coil and calculated the electric field strength induced at the amygdala.Estimation of electric field strength was determined using equations and data from the Handbook of Transcranial Magnetic Stimulation (Pascual-Leone 2002) and Antenna Theory: Analysis and Design (Balanis 2005).

The electric field strength produced by a simple SMS coil design at the distance of 10 cm was 2.5 V/m. This value is significantly below the electric field strength of TMS, 100 V/m.Despite a low calculated induced electric field, several parameters must still be investigated, including stimulation frequency, current amplitude, and turns of the coil. CT-PET studies have shown that high-frequency DBS can reduce activity of hypermetabolic areas. High-frequency SMS may have a similar effect on overactive brain tissue. SMS thus has the potential to be an effective treatment option for PTSD patients due to its targeted and noninvasive approach.

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